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Prevalence of Jumper's Knee Among Nonelite Athletes From Different Sports

A Cross-Sectional Survey

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Investigation performed at University Medical Center Groningen, Groningen, The Netherlands

Background: The prevalence of jumper's knee among nonelite athletes from different sports is unknown.

Purpose: This study was undertaken to determine the prevalence of jumper's knee in nonelite athletes from different sports and to determine potential risk factors for jumper's knee.

Design: Cohort study (prevalence); Level of evidence, 2.

Methods: The authors interviewed 891 male and female nonelite athletes from 7 popular sports in The Netherlands: basketball, volleyball, handball, korfbal, soccer, field hockey, and track and field. Using a specially developed questionnaire, information was obtained about individual characteristics (age, height, and weight), training background, previous and actual knee problems, and the VISA-P (Victorian Institute of Sport Assessment–Patella) score.

Results: The overall prevalence of current jumper's knee was 8.5% (78 of 891 athletes), showing a significant difference between sports with different loading characteristics. Prevalence was highest among volleyball players (14.4%) and lowest among soccer players (2.5%); it was significantly higher among male athletes (51 of 502 [10.2%]) than female athletes (25 of 389 [6.4%]) ($\chi^2 = 3.91$, $P = .048$). The mean duration of symptoms was 18.9 months (standard deviation [SD], 21.6; median value, 12.0; range, 2.0–59.8). The mean VISA-P score of the athletes with jumper's knee was 71.4 (SD, 13.8). Athletes with jumper's knee were significantly younger, taller, and heavier than those without jumper's knee.

Conclusion: Prevalence of jumper's knee is high among nonelite athletes and varies between 14.4% and 2.5% for different sports. Jumper's knee is almost twice as common among male nonelite athletes compared with female athletes. Different sport-specific loading characteristics of the knee extensor apparatus, a younger age, a taller body stature, and higher body weight seem to be risk factors associated with patellar tendinopathy.

Keywords: patellar tendinopathy; prevalence; risk factors; nonelite athletes

Jumper's knee (JK) is characterized by activity-related anterior knee pain and focal patellar or quadriceps tendon tenderness.⁴ Jumper's knee often causes prolonged morbidity and disability, and many athletes have to end their careers because of this overuse injury.^{15,19} The causes and underlying pathophysiology have not been completely elucidated so far. Repetitive microtrauma attributable to overuse may be considered as the initial disease factor;

microruptures of tendon fibers occur and several molecules are expressed including inflammatory cytokines, which act as disease mediators, while other released factors promote the healing process. Neural ingrowth that accompanies the neovessels explains the occurrence of pain and triggers neurogenic-mediated inflammation. This complex process of (neuro)inflammatory and degenerative changes finally leads to a painful tendinopathy with a failed healing response.^{1,16}

Prevention seems to be of the utmost importance, as treatment is often hampered by a lack of scientific evidence directing the management of this condition. Several treatments have been described, but which is the most appropriate treatment approach remains unclear.^{5,23} To develop preventive strategies for this condition, more insight into its magnitude and origins is necessary.^{12,26}

Some research has been conducted into the prevalence of JK, revealing an overall prevalence of 14% among elite athletes.¹⁹ Among elite volleyball and basketball players, a prevalence of 45% and 32%, respectively, has been reported.¹⁹ Little is known about the prevalence of JK in

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nonelite, recreational athletes however. Hence the aim of the present study was to estimate the prevalence of JK in nonelite athletes from different sports and to determine potential risk factors for this condition.

METHODS

Study Design

We performed a cross-sectional evaluation among male and female athletes from 7 different popular sports in the northern Netherlands: basketball, volleyball, handball, korfbal (a mixed-gender team sport, with similarities to netball and basketball; see Appendix, available online at <http://ajs.sagepub.com/supplemental/>), soccer, field hockey, and track and field (running, jumping, and throwing disciplines). Teams and athletes were randomly chosen and asked to participate in this study. Only athletes from community-based clubs and student teams (both groups usually practice 1-3 times a week) and who participated in the local or regional community-based club competition (usually 1 game per week) or recreational athletes were included. Professional players or athletes at the national elite level were excluded. After permission from the coaches, the interviews were scheduled right after a training session during the competitive season. All athletes who were present at the training agreed to fill out a specially developed questionnaire. The study was conducted according to the regulations of the Medical Ethical Committee at the University Medical Center Groningen, participation was voluntary, and it was explained that completing the questionnaire would be seen as consent to participate.

Questionnaire

Each athlete filled out a specially designed questionnaire under the supervision of a trained interviewer (available in the Appendix online). In the first part, information was obtained about gender, age, height, and weight. The second part included questions regarding sports participation: years of participation and number of hours per week. The third part was a structured medical history for previous and current knee problems. Each athlete went through this standardized interview, and the information requested included the following: (1) past knee injuries or complaints, previous diagnosis and treatment if a physician or physical therapist was consulted; and (2) current knee problems—side of symptoms, diagnosis and treatment if a physician or physical therapist was consulted, location of pain in a diagram of the knee, duration of symptoms, acute or gradual onset, symptoms during or after athletic activities.

The diagnosis of JK was deduced from several answers in the questionnaire combining (1) a typical history of gradually developed activity-related anterior knee pain; (2) a circumscribed most painful spot, pointed out in a diagram of the knee, at the upper or lower pole of the patella, in the patellar tendon, or at its tibial insertion; and/or (3)

previous diagnosis of this condition by a physician or physical therapist.

To assess severity, those athletes with current symptoms suggestive of JK also filled out the Dutch version of the Victorian Institute of Sport Assessment–Patella (VISA-P) questionnaire.^{27,29} This questionnaire consists of 8 questions, 6 of them rating pain during activities of daily living and simple tests of function on a visual analog scale ranging from 0 to 10 points, with 10 representing optimal health. Two questions concern the ability to participate in sporting activities. The maximum VISA score for an asymptomatic athlete is 100 points. The translated version of the VISA-P questionnaire is equivalent to its original version, has satisfactory test-retest reliability, and is a valid score to evaluate symptoms, knee function, and ability to play sports in Dutch athletes with patellar tendinopathy.

Data Analysis

The prevalence of JK was calculated for each sport separately and expressed as a percentage. A χ^2 test was used to determine whether the prevalence differed between the 7 sports and between males and females. Descriptive statistics were used for the characteristics of the athletes per sport, and an analysis of variance (with post hoc tests with Bonferroni correction) for a continuous variable or a χ^2 test for a dichotomous variable was used to determine whether there were differences between the sports. Mean (\pm standard deviation [SD]) VISA-P score and mean (\pm SD) duration of symptoms were calculated in athletes with JK. Characteristics of athletes with and without JK were compared using Student *t* tests. A *P* value $< .05$ was considered statistically significant. All analyses were performed using SPSS 16.0 (SPSS Inc, Chicago, Illinois).

RESULTS

Of a total 891 nonelite athletes, 76 currently had a JK, which is an overall prevalence of 8.5%. The prevalence differed between the 7 different kinds of sports ($\chi^2 = 21.5$, $P = .001$), and was highest in volleyball players (14.4%) and lowest in soccer players (2.5%) (Table 1). The prevalence was significantly higher in male athletes (51 of 502 [10.2%]) than in female athletes (25 of 389 [6.4%]) ($\chi^2 = 3.91$, $P = .048$).

There was a significant difference in age between sports; field hockey players were older than players of all other sports, except for soccer. There was also a significant difference in body mass index (BMI); track and field athletes had lower BMI compared with all other athletes, while handball players had higher BMI compared with all other athletes except for field hockey and soccer players. The male/female distribution was significantly different between sports. There was also a difference in height, weight, current number of training and match hours, and total years playing sports.

The mean VISA-P score of the athletes with JK was 71.4 (SD, 13.8). Their VISA-P score was not significantly different between sports (analysis of variance, $P = .94$). Mean

TABLE 1
Prevalence of Jumper's Knee in 7 Different Sports and Athletes' Characteristics^a

	Basketball	Volleyball	Handball	Korfball	Soccer	Field Hockey	Track and Field
No. of athletes	127	153	105	145	118	98	145
JK prevalence	11.8%	14.4%	13.3%	4.8%	2.5%	5.1%	6.9%
95% CI	7.3-18.6	9.7-20.8	8.1-21.1	2.4-9.6	0.9-7.2	2.2-11.4	3.8-12.2
Men	89 (70.1%)	76 (49.7%)	45 (42.9%)	76 (52.4%)	92 (78%)	49 (50.0%)	75 (51.7%)
Age, y	23.6 (4.3)	22.9 (2.7)	23.8 (5.2)	23.2 (4.2)	24.7 (5.1)	26.6 (6.2)	24.0 (4.5)
BMI, kg/m ²	22.5 (2.2)	22.2 (2.0)	23.5 (2.3)	22.5 (2.2)	23.0 (2.5)	22.7 (2.7)	21.1 (2.0)
Height, cm	186 (9.6)	182 (10.1)	179 (9.0)	180 (10.0)	181 (8.1)	179 (9.9)	178 (9.8)
Weight, kg	78.4 (11.1)	74.2 (10.9)	76.1 (11.9)	73.4 (11.2)	75.9 (11.0)	73.3 (12.4)	67.3 (10.1)
Sport history, y	9.3 (5.1)	9.9 (4.8)	13.8 (7.2)	15.1 (4.9)	16.5 (5.6)	15.5 (6.9)	8.7 (6.0)
Sporting per week, h	4.6 (1.8)	5.0 (2.2)	5.7 (4.1)	4.0 (1.3)	4.7 (1.7)	4.2 (2.1)	5.7 (3.2)

^aExcept for prevalence and gender, data are shown as the mean, with standard deviation in parentheses. JK, jumper's knee; CI, confidence interval; BMI, body mass index.

duration of symptoms was 18.9 months (SD 21.6; median value 12.0; range, 2.0-59.8). Age, height, and weight were significantly different between athletes with JK and those without. Athletes with JK were significantly younger (22.8 ± 3.1 years vs 24.1 ± 4.8 years; $P = .002$), were taller (185 ± 10.3 cm vs 181 ± 9.8 cm; $P = .001$), and weighed more (77.4 ± 11.1 kg vs 73.6 ± 11.6 kg; $P = .006$). Body mass index, total years playing sports, and current number of training and match hours did not differ between athletes with and without JK.

DISCUSSION

This cross-sectional survey among nonelite, recreational athletes from 7 different sports showed that the overall prevalence of JK varied between 2.5% (soccer) and 14.4% (volleyball). The overall prevalence in the sports included in this survey was 8.5%. Athletes with JK reported a mean VISA-P score of 71.4 (SD, 13.8) and had symptoms for 18.9 months (SD, 21.6; median value, 12.0; range, 2.0-59.8). No differences were found between the sports with regard to severity (VISA-P) or duration of JK symptoms. Athletes with JK were significantly younger, taller, and heavier than those without JK.

This is the first study to describe the prevalence of JK in nonelite athletes of different sports. The study's reported prevalence of 8.5% indicates that JK is also a common problem in this population and not only prevalent among elite athletes, albeit prevalence among the latter is higher. Lian et al¹⁹ showed a prevalence of current JK in male athletes of around 45% in volleyball, 32% in basketball, 23% in track and field, 15% in handball, and 12% in soccer, whereas in our survey a lower prevalence of 14%, 12%, 7%, 13%, and 3%, respectively, was found in these sports for both male and female athletes.

Because JK is considered to be an overuse injury that affects men more than women, the inclusion of female athletes in our study explains part of the difference in prevalence found between elite and nonelite athletes. In line with previous studies, we also found a significantly higher prevalence in male athletes (51 of 502 [10.2%]) than in female

athletes (25 of 389 [6.4%]).^{13,19} It remains unclear why JK affects more men than women but some hypotheses have been postulated. One explanation could be that women have less quadriceps strength and inferior jumping capacity, so the patellar tendon is exposed to lower forces.²¹ Estrogen may play a protective role against tendinopathies,¹³ although other studies have shown that estrogen inhibits exercise-induced collagen synthesis in the human tendon and leads to a lower rate of tendon tissue repair.^{14,22} In any event, the difference between the prevalence of JK found in elite athletes and nonelite athletes cannot solely be explained by the fact that our study also included female athletes.

It is reasonable to assume that the number of training hours also plays a role. The elite athletes included in the study of Lian et al practiced more than 12 hours per week, whereas in our study the total number of weekly sporting hours was only 4 to 5. Ferretti¹¹ already described a linear relationship between training volume and prevalence of JK in volleyball players.

The prevalence of JK was highest in basketball, volleyball, and handball, all indoor sports characterized by high demands on speed and power for the leg extensors. There seems to be an association between sport-specific knee-loading characteristics, playing surface, and prevalence of JK. Korfball (see Appendix online), a typical Dutch sport also with many jumping, cutting, and sprinting activities, had a much lower prevalence, which might be partly explained by the fact that most of the time it is played outdoors on a softer natural grass pitch. Field hockey, not a typical jumping sport but played on hard artificial turf, showed a higher prevalence than soccer. In a study among elite beach volleyball players, who jump and land in soft sand, a prevalence of 9% has been reported, which is much lower than the rate for indoor volleyball players.³ It therefore seems plausible that the higher the mechanical overload on the tendon, the greater the risk for developing a JK. Studies are needed to elucidate the exact underlying pathophysiologic mechanism of patellar tendinopathy caused by this repetitive overloading of the tendon.

Age, height, and weight were found to be significantly different between nonelite athletes with and without a JK. This result is in contrast to many other studies. We

have recently reviewed the literature on etiologic factors associated with patellar tendinopathy and found strong-to-moderate evidence that age,^{10,11,13,18,19,28} weight in females,^{9,10,13,17,20,28} and height^{9,10,13,17,18,20,28} are *not* associated with patellar tendinopathy. Most of these studies, however, were performed on high-level athletes. There may be different risk factors for elite and nonelite athletes; more research on the latter group is thus needed.

When interpreting our results, some methodologic issues must be considered. The diagnosis of JK was deduced from the questionnaire and was based on the typical history, location of tenderness on a pain map, and/or a previous diagnosis by an independent practitioner. No clinical examination by a (sports medicine) physician was performed and no MRI or ultrasound imaging was done. This might have influenced the results of our study. However, several studies have used self-administered pain maps for the inclusion of subjects with JK.^{7,8} The location of knee pain as indicated on a self-administered pain map corresponds very well with the actual pain location.²⁴ Furthermore, the diagnostic method with a self-administered pain map appeared to be quite reliable in a previous study.³⁰ Out of a group of 268 athletes who, based on the questionnaire criteria, were classified as having JK, 45 athletes were invited to participate in an intervention study. Jumper's knee was diagnosed by an experienced sports medicine physician in 44 of the 45 subjects, demonstrating that the number of false positives was very low. As for the lack of MRI and ultrasound imaging, it is also well-known that there is limited correlation between clinical symptoms and ultrasound or magnetic resonance imaging.^{6,25} Pain can exist without detectable tendon changes, but athletes can also have imaging abnormalities of their tendon without symptoms of JK. Magnetic resonance and ultrasound imaging thus increase the likelihood of a clinical diagnosis being made but are not the gold standard. Thus we believe that the method used in this study is a valid one to diagnose JK in large cohorts.

Another limitation is that only those athletes who were able to practice filled out the questionnaire, because the interviews were held directly after the training sessions. Anecdotal evidence shows that at least 3 athletes did not participate in the practice session because of a JK problem and that 2 stopped for the same reason. Hence the prevalence found in this study might even be an underestimation of the problem.

In the setting of sports injury prevention research, it is therefore important to realize that JK is a common, often chronic condition among recreational athletes too.^{12,26} Although it is not a time-loss injury, it can negatively influence an athlete's career. Many athletes with JK keep on playing sports, and based on VISA-P scores of 71 and symptom duration of more than 1.5 years, it can be concluded that their athletic performance is chronically hampered by their knee problem. This phenomenon of "no injuries, but plenty of pain" has recently been described by Bahr.² The next step is more research into etiologic factors and injury mechanisms to determine potential strategies that can reduce the load on the patellar tendon. Only then can preventive measures be developed and introduced that reduce the risk of sustaining this common and bothersome injury.

CONCLUSION

Prevalence of JK is high among nonelite athletes and varies between 14.4% and 2.5% for different sports. Jumper's knee is almost twice as common among male nonelite athletes than among female athletes. Different sport-specific loading characteristics of the knee extensor apparatus seem to be risk factors associated with patellar tendinopathy.

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